MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

PCM0016 – CHEMISTRY

(All sections / Groups)

13 OCTOBER 2018
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages only excluding the cover page.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

(a) (i) Define an ionic compound. [1 mark]

(ii) Complete the table below by giving one example (symbol and name) for each aspect:

Aspect	Symbol	Name
Ionic compound of metal with one charge	(i)	(ii)
Ionic compound of a transition metal	(iii)	(iv)

[2 marks]

(b) When iron (II) hydroxide [$Fe(OH)_2$] is mixed with phosphoric acid [H_3PO_4], iron (II) phosphate [$Fe_3(PO_4)_2$] precipitate results. Another product is water.
[Atomic mass: Fe = 55.9; H = 1.0; O = 16.0; P = 31.0]

(i) Write a balanced equation for the above reaction. [1 mark]

(ii) If 3.20 g of $Fe(OH)_2$ is treated with 2.50 g of phosphoric acid, what is the limiting reagent and what is the reactant in excess? [2 marks]

(iii) Calculate the maximum weight (in grams) of $Fe_3(PO_4)_2$ precipitate can be formed. [1 mark]

(iv) If 3.99 g of $Fe_3(PO_4)_2$ is actually obtained, find the percent yield. [1 mark]

(c) Give examples of the crystalline form of carbon and draw their structures.

Crystalline Form	Form 1	Form 2
Name of form		
Structure (Draw)		

[2 marks]

(d) A compound containing 40.0 % carbon, 5.7 % hydrogen and 53.3 % oxygen has molecular mass of 175 g/mol.
[Atomic mass: C = 12.0; H = 1.0; O = 16.0; $N_A = 6.023 \times 10^{23}$]

(i) Write the molecular formula of the compound. [1.5 marks]

(ii) Calculate the number of hydrogen atoms in one mole of the compound. [1 mark]

Continued...

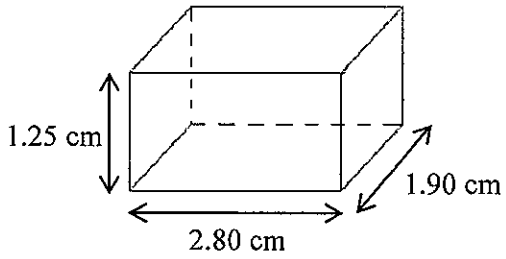
(e) Table below shows the advantages and disadvantages of homogeneous versus heterogeneous catalysts. Briefly explain what contributes to such properties in both substances.

Homogeneous	Heterogeneous
Difficult separation	Easy separation
Expensive recycling	Simple recycling

[2 marks]

(f) How many liters of hydrogen gas are necessary to react with 10 grams of nitrogen to produce ammonia at standard temperature and pressure?
[Atomic mass: N = 14.0; H = 1.0] [3 marks]

(g) A small block of dry ice (solid CO_2) with density of 1.56 g/mL is sealed inside a balloon and allowed to sublime at 22.0 °C and 749 torr. The dimensions of the gas block (dry ice) are as below. Find the final volume of the balloon.
[Atomic mass: C = 12.0; O = 16.0; 1 cm^3 = 1 mL; R = 0.0821 L·atm/K·mol] [3 marks]



(h) Methane is reacted with steam to produce a mixture of carbon monoxide and hydrogen following the equation:

$$CH_4\,(g) + H_2O\,(g) \rightarrow CO\,(g) + 3H_2\,(g)$$

Use the data below to calculate the enthalpy change, in kJ for the forward reaction.

Equation	ΔH (kJ)
$CO\,(g) + \frac{1}{2}O_2\,(g) \rightarrow CO_2\,(g)$	−283
$H_2\,(g) + \frac{1}{2}O_2\,(g) \rightarrow H_2O\,(g)$	−242
$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g)$	−803

[2 marks]

(i) A photon is emitted as atom makes a transition $n = 5$ to $n = 3$. Calculate the energy of the emitted photon and briefly discuss the stability of the electron as it drops.
[$R_H = 2.18 \times 10^{-18}$ J] [1.5 marks]

Continued...

(j) Complete the sentences below:

Measure of the random motion of molecules is known as _____(i)_____. Flow of energy due to a temperature difference is known as _____(ii)_____. [1 mark]

QUESTION 2 [15 MARKS]

(a) The following combinations of four quantum numbers are not allowed. Correct each set by changing only one quantum number. Then, give the orbital name for each of the following:

False quantum numbers	Corrected quantum numbers	Name of orbital (e.g.: 1*s*, 2*p*)
(i) (3, 1, -2, +1/2)		
(ii) (4, 3, +1/2, -1/2)		

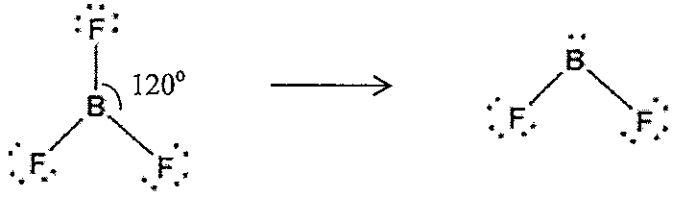
[2 marks]

(b) Draw the electronic configuration, deduce the group and period and predict the block in the Periodic Table for following elements:

Element	Electronic configuration	Group and period	Which Period Table Block?
(i) ^{30}Zn			
(ii) Argon			

[3 marks]

(c) The molecular geometry for BF_3 and BF_2 are shown below. Answer the following questions.



(i) How many lone pairs are there in BF_2 molecule? [0.5 mark]

(ii) Each of the three FBF angles is 120° in BF_3. Predict the FBF angle in BF_2 molecule. Explain your answer. [1 mark]

(iii) State the molecular geometry for BF_2 molecule. [0.5 mark]

(d) Draw the Lewis structure for carbon disulfide (CS_2). [1 mark]

Continued...

(e) For main-group elements, explain the observed trends in electronegativity as you move across a period in the Periodic Table. [1 mark]

(f) Consider the following reaction between nitrogen dioxide and carbon monoxide.

$$NO_2\,(g) + CO\,(g) \longrightarrow NO\,(g) + CO_2\,(g)$$

The initial rate of the reaction was measured at different reactants' concentrations as in table below:

Experiment	$[NO_2]$	[CO]	Initial rate M/s
A	0.1	0.01	0.328
B	0.2	0.01	2.624
C	0.1	0.02	0.328

From the data, determine each of the following:
(i) The rate law for the reaction. [1.5 marks]
(ii) The rate constant, *k* for the reaction. [1 mark]

(g) At 40 °C, the second-order reaction $N_2O_5\,(g) \rightarrow 2NO_2\,(g) + \frac{1}{2}O_2\,(g)$ is half way complete after 2.5 hours when the initial concentration of N_2O_5 is 3.75 mol/L. Calculate how long will it take for the reaction to be 95% complete. [2 marks]

(h) Referring to the reaction below:

$$2H_2S\,(g) + O_2\,(g) \rightleftharpoons 2S\,(g) + 2H_2O\,(g)$$

(i) Predict what will happen to the concentration of H_2O if some amount of O_2 is removed from the system. [0.5 mark]
(ii) What is likely to happen if the concentration of H_2S is increased? [0.5 mark]
(iii) Predict the effect on the equilibrium system if a catalyst is added. [0.5 mark]

QUESTION 3 [15 MARKS]

(a) NH_3 does not ionize completely when dissolved in water.

(i) Write down the complete reaction equation of NH_3 in water. [1 mark]
(ii) Label the conjugate acid-base pairs of the reaction. [1 mark]

Continued...

(b) The pH of a 0.12 M solution of a weak acid, HA, is 3.92 at 400 K.

(i) Write an expression for the acid dissociation constant, K_a, of HA, and determine the value of K_a for this acid at 400 K. [2 marks]

(ii) The dissociation of HA into its ions in aqueous solution is an endothermic process. How would its pH change if the temperature were increased? Explain your answer. [1.5 marks]

(c) For the table below, answer (i), (ii), (iii) and (iv).

Solution	pH	$[H^+]$	pOH	$[OH^-]$	Acidic, basic or neutral?
1	(i)	-	10.8	(ii)	-
2	-	(iii)	-	3.79×10^{-7}	(iv)

[2 marks]

(d) A 0.5 *M* ethanoic acid, CH_3COOH is 9.5% dissociated. Calculate the pH of the acid. [1.5 marks]

(e) A voltaic cell with a copper bar and a zinc bar are immersed in $CuSO_4$ solution and $ZnSO_4$ solution respectively. A salt brige of KCl solution is used in the cell.

(i) Write the half-reactions and the net reaction for the electrolysis. [1.5 marks]

(ii) Explain the function of salt bridge and state the requirement of the selection for the solution in the bridge. [1 mark]

(f) The half-reactions of electrolysis of molten barium chloride, $BaCl_2$ is given as below:

Anode : $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$
Cathode : $Ba^{2+}(aq) + 2e^- \rightarrow Ba(s)$

If a certain amount of current is being supplied for an hour in order to produce 2.8 g of Ba metal, calculate the required amount of current.
[Atomic Mass: Ba = 137.3; Faraday constant = 96500C/mol e^-] [2 marks]

(g) One kilogram of copper and one kilogram of magnesium are produced by electrolysis process. By considering only the electricity cost of the electrolysis process, which metal has cheaper production cost. Explain your answer.
[Atomic Mass: Mg = 24.3 and Cu = 63.5] [1.5 marks]

End of Paper